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A Bibliometric Analysis of Artificial Intelligence in the Banking Sector: Trends, and Future Directions

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Abstract:

This study conducts a bibliometric analysis of artificial intelligence (AI) in the banking sector, focusing on recent trends and future directions. Using VOSviewer for mapping, the study examines publication patterns, high-impact papers and journals, influential countries and authors, and thematic clusters in the AI and banking sectors. The study findings indicate significant growth in AI-related publications from 2019 to 2024, driven by applications in fraud detection, customer service automation, and risk management, underscoring the banking sector's reliance on digital transformation. Key thematic clusters identified include cybersecurity, digital infrastructure, customer analytics, operational efficiency, and ethical considerations. The analysis highlights AI's transformative role in enhancing banking efficiency and customer satisfaction, with substantial contributions from South Asia, Europe, and North America. The study limitations related to data sources and collaborative efforts point to opportunities for interdisciplinary and international research expansion. The study provides valuable insights for academia, industry practitioners, and policymakers, addressing research gaps and recommending pathways for a sustainable and inclusive integration of AI in banking.

Keywords: Artificial Intelligence, Banking Sector, Digital Transformation, Cybersecurity, Future Directions, AI Trends.

1. Introduction

The banking sector has been accepting technology for transactions that leverage the sharing of data, in most instances across diverse networks and the worldwide turf of wealth in databases (Javaid et al., 2022). Modern technologies, particularly artificial intelligence (AI), are transforming key areas of the banking industry, including privacy and security, wealth generation, contract management, and accounting. Through AI, banks are increasingly collaborating with fintech firms to enhance their digital offerings and continuously provide improved services for their clients. The banking industry (Manoharan et al., 2023) has seen a dramatic leap in progress in the last few years because of breakthrough technology. Looking

ahead, the banking sector plans to contain mobile banking, online banking, and the seamless transfer of funds to merge sales, technological growth, and telecommunication. AI and cognitive technologies enable rapid competition from FinTech companies, allowing them to fully leverage digitization benefits (Lourens et al., 2022).

The primary beneficiaries of Artificial Intelligence, among the biggest disrupting trends in the 21st century, are banking institutions. Banks are increasingly adopting AI technology to enhance customer satisfaction, reduce risks, and drive growth in the banking sector (Bueno et al., 2024).

Applications of AI include the increasing popularity of natural language processing (NLP), machine learning, and robotic process automation (RPA) for customer service automation, creditworthiness assessment, fraud detection, and personalized banking. These trends can be taken together as indications of how relevant AI is going to be for the digital evolution of the financial sector (Ng et al., 2021). The integration of AI into the banking industry reflects a significant change in the business operations of financial institutions. Reports indicate that, from 2021 to 2028, Global AI in the financial sector is expected to grow at a CAGR of over 32%. Such rapid growth could correlate with the increasing need the financial services industry is developing in the entire process of digitalization and AI-driven analytics (Dwivedi, et. al., 2021). For instance, banks are now looking for AI solutions because of the need for enhanced security and risk management coupled with better compliance with regulatory requirements. Using technology, banks can now analyze huge amounts of data that allow them to make better decisions and plans (Königstorfer et al., 2020).

In this context, AI marks a multifunctional development in the sector of banking since it compiles different applications that are required to improve processes and deliver services (Ochuba, et. al., 2024). Among the most significant areas where AI has brought forth significant improvements relates to fraud detection. AI-based systems, from pattern analysis of transactions, automatically detect anomalies and flag suspicious activities in real-time. This has proven very important in combating financial fraud and enhancing the safety of banking operations. AI has been used to foster personalized banking solutions that would go ahead to enhance the experience of customers. An example is AI-powered chatbots and virtual assistants that offer real-time support to customers to respond to their questions as well as banking services without necessarily requiring human intervention (Kushwaha, et. al., 2021). In addition to enhancing customer satisfaction, AI also reduces costs for the banks. Another area where AI's capacity for

data analysis has been very beneficial is in credit risk assessment and lending decisions. Evaluation of people's creditworthiness through machine learning algorithms rather than traditional methods may be evaluated with a much higher accuracy than before, which would mean an otherwise better lending decision by a bank (Lappas, et. al., 2021). This diminishes the likelihood of loan defaults and enhances the general productivity of credit management. Another critical sphere is regulatory compliance and risk management, where AI starts to make its mark. The financial services sector is sharply regulated, and there exists a very stringent regimen of compliance that banks have to follow. AI solutions, especially those based on natural language processing, will be able to help banks navigate complex regulatory frameworks by applying automation mechanisms for monitoring and reporting compliance (Yang, et. al., 2024).

The role of AI in banking is well-established, and recent studies have significantly increased regarding AI in this sector; bibliometric analysis is helpful for this purpose. Bibliometric analysis is a quantitative technique used for the scrutiny of research outputs, the revelations of emerging trends, and the identification of seminal works in a specific discipline (Yang, et. al., 2023). The analysis will help map the intellectual structure of the study base to display an all-inclusive view of all the advancements in AI and its applications in banking through citation counts, co-authorship networks, keyword occurrences, and publication trends in bibliometric analysis (Morshidi, et. al., 2024). In analyzing the role of AI in the banking sector, bibliometric analysis enables a person to assess the volume of published work, the presence of important scholars and institutions, and the availability of some geographic distribution of research. Rather, it can also reveal which themes or topics are oftentimes most discussed, such as AI in fraud detection, automation of customer services, and risk management. Meanwhile, it highlights some gaps in existing research already conducted to be continued in their quest for exploration and discovery.

a) Trends of Artificial Intelligence in the Banking Sector

According to Manjaly et al. (2021), AI in banking can combat fraudulent transactions, improve compliance, and reduce costs by increasing productivity. Factors like awareness, attitude, subjective norms, perceived usefulness, and knowledge of AI technology have a significant and positive relationship with the intention to adopt AI in the banking sector (Noreen et al., 2023). According to Königstorfer et al. (2020), AI in commercial banks can reduce losses in lending,

increase security in processing payments, automate compliance-related work, and improve customer targeting. AI elevates the quality of banking transactions but cannot replace human interactions in client-employee relationship management (Boustani et al., 2021). FinTech in the banking industry has evolved rapidly, affecting various stakeholders, including customers, companies, banks, regulation authorities, and society (Elia et al., 2022). In a study, Fundira, et. al., (2024) emphasize the value of improving digital skills and removing obstacles to inclusion in the South African banking industry, stressing the moral application of AI to promote sustainable digital banking practices and offering stakeholders practical suggestions.

b) Future of Artificial Intelligence in the Banking Sector

The study examines the global trends and future directions of AI-driven banking, highlighting the balance between innovation and regulation in FinTech, with a focus on ensuring financial stability, security, and compliance while embracing the potential of AI and digitization in banking operations (Ali et al., 2024). Al-Jaroodi (2019) highlights the potential of blockchain to revolutionize various industries, improving security, efficiency, and transparency in banking, healthcare, logistics, education, and government. Thamrin et. al. (2024) also anticipate wider adoption and integration with AI and IoT for innovative future solutions. Varadarajan, et. al. (2024) highlight that AI and ML technologies are revolutionizing the banking sector by enhancing productivity, precision, and decision-making while effectively reducing risks, particularly through fraud detection and personalized customer support via chatbots and virtual assistants.

Many conveniences are ushered in by AI into the banking industry, but it does bring some issues along with it. A major issue is data confidentiality and security. Since most applications of AI in banking are related to the processing and storage of sensitive client information, one becomes alert to the issue of possible data breaches and cyber-attacks (Kshetri, et. al., 2017). Security measures need to be developed and further enhanced to protect the information of clients. Another challenge is the integration of AI technologies with the traditional legacy banking system. Most of the traditional banks are still using systems that are not in concert with modern AI technologies. The same presents a barrier to AI adoption since the banks need to invest in changing their infrastructure to accommodate AI solutions (Jyothi, et. al., 2024). The integration of AI in banks requires a more qualified workforce that can operate and maintain AI

systems, which has become one of the constraints on the number of institutions integrating AI in their systems. The question of ethics on the integration of AI in banking also becomes one of the issues of concern. Questions over unfairness and accountability of decisions made through AI have forced various questions, especially regarding biases of algorithms and transparency in the decision-making processes (Akter, et. al., 2021). With the rise of Artificial Intelligence as an ever-stronger player in banking, some clearance needs to be available in these ethical considerations to guarantee rational and fair use of technology.

AI presents a growing influence over the banking sector, which renders it imperative to have an array of knowledge regarding the study landscape in this domain. The proposed bibliometric analysis of AI research in banking serves to offer some glimpses into current trends, advancements, impacts, and

emerging areas. The former will chart out the future of studies in the field by elucidating the volume of research, core topics selected, and leading contributors. Another significant consideration is the geographical variation seen in the output of AI research. Although a sudden spike in AI research within banking is witnessed all over the world, there exists a variance in regional contribution. Such an understanding of regional trends is instrumental in drawing a balance between global cooperation and dealing with market-specific issues. Finally, the below bibliometric survey will present future directions of development for AI in banking. After all, the banking industry will surely continue to evolve with the advent of new technologies like quantum computing and explainable AI. These will enable the identification of research gaps and set suggestions for future research directions, especially in the Indian banking sector.

As AI systems tend to intrude upon many facets of our existence, the AI algorithms need to be correct but also unbiased and fair while exercising these very tasks, be it monitoring, prediction, or recommendation (Angelucci, et. al., 2022). Many decisions taken by AI systems perpetuate, instead of combating, harmful biases and culminate into cases of discrimination directed toward race or gender and even sexual preferences (Rahwan, et. al., 2019). AI is transforming the banking sector in the insurance business by providing the efficiency, security, and customer satisfaction that banks require. However, this fast growth in AI-based offerings in the banking sector also poses some challenges, such as issues related to data privacy, infrastructure integration, and ethical considerations. Bibliometric analysis has the potential to analyze the current trends in the study, key contributors, and future research avenues. With the

continuous advancement of artificial intelligence, further studies play an important role in solving these problems and providing more possibilities for further application within banking.

2. Research Methodology

2.1 Research Questions

In this study, the visualization of similarities (VOS) mapping approach of the VOS viewer software program is used to complement the bibliometric analysis. As a result, the particular research inquiries that inform this study include:

“RQ1: What are the publication trends, and future direction in artificial intelligence in the banking sector over the last 5 years?”

This question aims to identify the growth and trajectory of research in this field, highlighting significant changes and patterns in publication output.

“RQ2: Which papers and journals have the highest production impact in the study of artificial intelligence in the banking industry?”

This question seeks to pinpoint the most influential publications and journals contributing significantly to the development and dissemination of knowledge in this area.

“RQ3: Which countries, institutions, and authors are the most influential in the research on artificial intelligence and the banking sector?”

This question examines the geographical distribution of research output and identifies key contributors and leading authors in the field.

“RQ5: How has the focus of research on artificial intelligence and the banking sector evolved?”

This question investigates shifts in research focus, identifying emerging trends and new priorities within the domain.

2.2 Search Strategies

Publicized in Scopus relevant publications will be used to achieve the specific objectives as it contains factors and relevant information regarding "Artificial Intelligence in the Banking Sector between 2019 and 2024." This choice has been made because the Scopus database is a

bibliographic database containing more impactful publications in social sciences and finance/economics. This site is useful for doing much bibliometric analysis, as it has great abstracts and accurate citation counts (Garcia, et. al., 2018). In addition, Scopus indexes more than 25 million publications from over 7,000 publishers worldwide and offers complete coverage together with trustworthy data to evaluate research.

Relevant literature was retrieved using the following parameters: TITLE-ABS-KEY ("Artificial Intelligence") AND TITLE-ABS-KEY ("Banking Sector") OR TITLE-ABS-KEY ("Banking Industry"). The study chose the search terms to cover a wide range of publications that discuss artificial intelligence in the banking sector, making it a comprehensive dataset.

The search strategy also employed specific filters:

Time Frame: Since the study requires examining the pattern during the last five-year cycle, papers from January 2019 to September 2024 were analyzed to illustrate the trend across a broad time frame.

Language: Only English-language articles were considered to maintain consistency and provide access for analysis by the bibliometric software.

The study imported bibliographic data, such as authors, years of publication, and citations utilizing abstracts, by downloading search results in CSV format using the export of the Scopus database. The mapping of knowledge structures and identification of co-authorship networks in conjunction with growing research hotspots enabled a systematic approach that was sufficiently resilient to allow a thorough analysis of the research area on artificial intelligence and the banking sector.

Table 1: The criterion of determining what is included and excluded

Criterion	Inclusion	Exclusion
Publication Type	Articles and Reviews, Editorials, Letters, Notes, Books, Erratum, Editorial	None
Thematic Areas	All thematic areas relevant to "Artificial Intelligence and Banking Sector"	Irrelevant thematic areas (e.g., unrelated fields)
Geographical Scope	All countries/territories	None
Language	English	Non-English languages
Timeframe	The study considers the research from January 2019 to September 2024	Before January 2019 and after September 2024
Document Type	Original research, empirical studies, theoretical papers, and systematic reviews	Grey literature, non-scientific publications, non-peer-reviewed reports

Source: Author's Elaboration

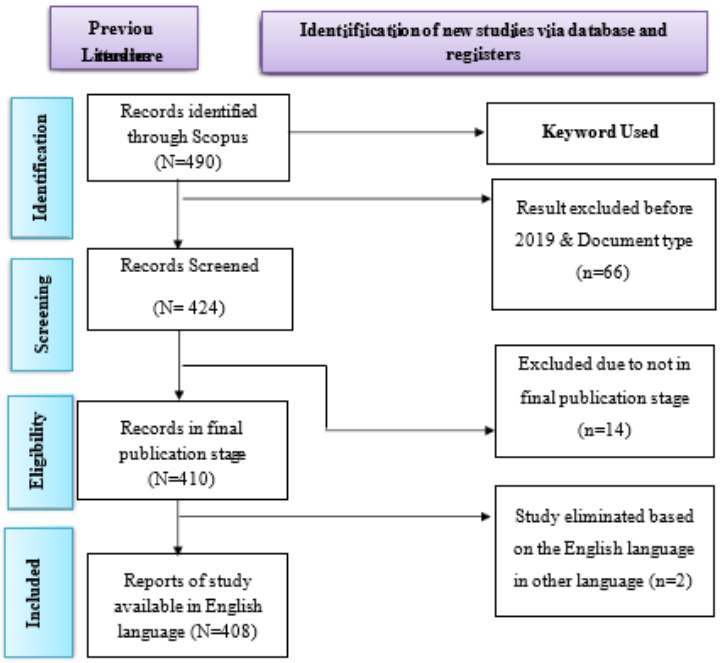

Figure 1: Flowchart of Screening Source: Author Own Elaboration

Document pre-processing was performed to remove duplicates and address missing values in the metadata of articles from the Scopus database. The dataset has 408 articles at the end. CSV data were acquired, and Microsoft Excel with Microsoft 365 was then used to handle the data. VOSviewer 1.6.20 was used for the actual analysis that followed the data treatment. A powerful tool for making, displaying, and examining scientific maps is VOSviewer (Ninova, et. al., 2024). Additionally, the study offers graphical maps that make it easier to understand and analyze the networks connecting different nations, organizations, journals, authors, and keywords (Dodge, et. al., 2011).

3. Results

This section provides a concise overview of the research's results. The primary discoveries are discussed, and recommendations for future investigation are provided. Table 2 displays a concise overview of the outcomes.

Table 2: Summary of Data

Outcomes	Total Number
final sample (papers)	408
Authors	22377
Sources	288
Keywords	2029
Citations	14062
Countries	75
Affiliations	842

Source: Author's Elaboration

3.1 Keyword Search

The keyword search carried out on October 14, 2024, produced an overall count of 408 publications. Among the 408 total publications, there are 155 conference papers, 148 articles, 74 book chapters, 19 conference reviews, 7 books, and 5 reviews. These numbers are illustrated in Figure 2.

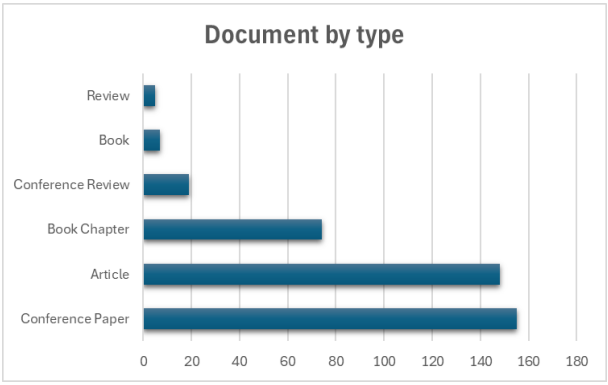

Figure 2: Documents by type Source: Author's Elaboration

3.2 Trends In Publishing Numbers Throughout Research Tenure

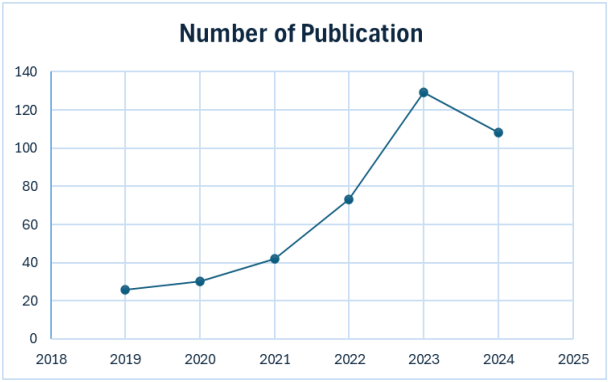

Figure 3: Number of Publication Source: Author's Elaboration

From the analysis of publication trends from 2019 to 2024, noticeable steps of research activity are shown with different fluctuations. The year 2019 made a beginning to the field with 26 publications. This grew modestly to 30 publications in 2020, with a 15.38% increase, suggesting a bit of pressure in that gradual buildup of research engagement. The following year, 2022, reached a staggering high with 73 publications, signifying a 73.81% increase and reflecting a higher interest and activity from the research community. The peak was achieved in 2023 with 129 publications, up by a staggering 76.71% from the previous year, further testament to the height of research activity and interest in the field. However, the year 2024 saw a little decline with 108 articles recommended, a 16.28% decrease from the year before, which may indicate a shift in research focus or the need for consolidation. Overall, there is a steady increase in the years from 2019 to 2023, indicating steadily pent-up demand within the research field while a tapering down in 2024 could just be an assertion of stability or a change in focus at that juncture. This contrasted pattern reflects the changing shore of interest and development within the field.

3.3 Most Cited Publication

According to the Scopus criteria for “highly cited papers,” these are the most-cited publications on artificial intelligence in digital banking.

Authors	Title	Year	Source Title	Cited by
Suhel S.F.; Shukla V.K.; Vyas S.; Mishra V.P.	Conversation to Automation in Banking through Chatbot Using Artificial Machine Intelligence Language	2020	ICRITO 2020 - IEEE 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)	88
Lee J.-C.; Chen X.	Exploring users' adoption intentions in the evolution of artificial intelligence mobile banking applications: the intelligent and anthropomorphic perspectives	2022	International Journal of Bank Marketing	87
Wijayati D.T.; Rahman Z.; Fahrullah A.; Rahman M.F.W.; Arifah I.D.C.; Kautsar A.	A study of artificial intelligence on employee performance and work engagement: the moderating role of change leadership	2022	International Journal of Manpower	84
Tsolas I.E.; Charles V.; Gherman T.	Supporting better practice benchmarking: A DEA-ANN approach to bank branch performance assessment	2020	Expert Systems with Applications	75
Romao M.; Costa J.; Costa C.J.	Robotic process automation: A case study in the banking industry	2019	Iberian Conference on Information Systems and Technologies, CISTI	61
Rahman M.; Ming T.H.; Baigh T.A.; Sarker M.	Adoption of artificial intelligence in banking services: An empirical analysis	2023	International Journal of Emerging Markets	52
Rodrigues A.R.D.; Ferreira F.A.F.; Teixeira F.J.C.S.N.; Zopounidis C.	Artificial intelligence, digital transformation and cybersecurity in the banking sector: A multi-stakeholder cognition-driven framework	2022	Research in International Business and Finance	52
Naimi-Sadigh A.; Asgari T.; Rabiei M.	Digital Transformation in the Value Chain Disruption of Banking Services	2022	Journal of the Knowledge Economy	51
Doumpos M.; Zopounidis C.; Gounopoulos D.; Platanakis E.; Zhang W.	Operational research and artificial intelligence methods in banking	2023	European Journal of Operational Research	46
Indriasari E.; Gaol F.L.; Matsuo T.	Digital Banking Transformation: Application of Artificial Intelligence and Big Data Analytics for Leveraging Customer Experience in the Indonesia Banking Sector	2019	Proceedings - 2019 8th International Congress on Advanced Applied Informatics, IIAI-AAI 2019	46

Figure 4: 10 Most Cited Publication Source: Author's Elaboration

The Top 10 Cited Articles on Artificial Intelligence (AI) in Banking shows key contributions to the field by 2019-2023. The most cited paper: Conversation to Automation in Banking through Chatbot Using Artificial Machine Intelligence Language by Suhel et al. (2020), published in the

ICRITO Conference Proceedings, has been cited 88 times, highlighting the role of chatbots in automating the functions of banks. The second most cited is Exploring Users' Adoption Intentions in the Evolution of Artificial Intelligence Mobile Banking Applications: The Intelligent and Anthropomorphic Perspectives by Lee and Chen (2022), which gathers 87 citations from The International Journal of Bank Marketing, focusing on the user adoption of AI mobile banking. Another significant contribution emanates from Wijayati et al. (2022), with their

International Journal of Manpower contribution receiving 84 citations for examining the effects of AI engineering on employee performance and engagement. Tsolas et al. (2020) presented a DEA-ANN strategy for evaluating bank branch performance in their work published in Expert Systems with Applications, which has received 75 citations. This study methodology successfully connects artificial intelligence with operational research. The paper by Romao et al. (2019), with 61 citations, titled Robotic Process Automation: A Case Study in the Banking Industry and details the mechanics of automation applications through banking processes. Additional publications include Rahman et al. (2023) empirical analysis on AI adoption in developing markets that has received 52 citations in the International Journal of Emerging Markets, along with Rodrigues et al. (2022) publication on "Artificial intelligence, digital transformation and cybersecurity in the banking sector: A multi-stakeholder cognition-driven framework" in Research in International Business and Finance, also cited 52 times. Works authored by Naimi-Sadigh et al. (2022) engage in discourse on digital disruption as being published in the Journal of the Knowledge Economy, with a total of 51 citations. Moreover, finally, the research by Doumpos et al. (2023) done by the European Journal of Operational Research and Indriasari et al. (2019) in the conference proceedings of the IIAI-AAI Congress, which has managed to draw 46 citations apiece, are about how AI integrates into the fields of operational research and customer experience, respectively. These articles are significant contributions to the understanding of AI's role in banking since the number of citations indicates their importance for further shaping research. The leading paper of Suhel on Conversation to Automation in Banking through Chatbot Using Artificial Machine Intelligence Language has just above Contracts of 88.

3.4 Most Effective Authors

This review surveyed 408 publications and revealed that 22,377 contributors were actually behind those publications; some authors had taken part in more than one study. Accordingly, Table 3 is an account of the top 10 authors who have greatly contributed to the literature on artificial intelligence in the banking sector, based on their number of published papers; the table gives the authors' names, number of papers, h-index, and citations.

Table 3: 10 Most Effective Authors

Rank	Author	TC	TP	University	h-index
1	Hamdan, A.	15	4	Ahlia University, Manama, Bahrain	26
2	Singh, R.	20	4	Uttaranchal University, Dehradun, India	34
3	Dewasiri, N.J.	4	3	Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka	8
4	Gaol, F.L.	11	3	Bina Nusantara University, Jakarta, Indonesia	16
5	Indriasari, E.	12	3	Bina Nusantara University, Jakarta, Indonesia	5
6	Kathuria, S.	3	3	Uttaranchal University, Dehradun, India	7
7	Kulachinskaya, A.	2	3	Peter the Great St. Petersburg Polytechnic University, Saint Petersburg, Russian Federation	5
8	Kumar, R.	9	3	Uttaranchal University, Dehradun, India	4
9	Lomakin, N.	4		Volgograd State Technical University, Volgograd, Russian	3

			3	Federation	
10	Srivastava, A.	9	3	National Forensic Sciences University, Gandhinagar, India	3

Source: Author's Elaboration

The table above can be visualized which the prominent researchers in the banking sector through AI applications by productivity and citation impact. Although Singh, R. and Hamdan, A. are the most influential by having more citations and an h-index, other authors from the institutions of Uttaranchal University and Bina Nusantara University are of higher productivity that may signal strong institutional strengths in this field of research. Several authors' lower h-indices denote greater scopes of further growth in their academic influence, which should be realized as the research in this area matures and gets more recognition within AI-focused banking research. The geographical spread of the contributors also indicates that AI application research in banking is a

pan-global collaborative work and could be identified with characteristic regional centers in South Asia, Southeast Asia, and Eastern Europe. Based on this analysis, potential collaborative ideas can be derived and delved into a world map of AI in banking research.

3.5 Most Influential Journals

Table 4: The top 10 publication Sources based on the number of publications

Journal Name	TP	TC	CPP	Cite Score	SNIP	SJR
Lecture Notes In Networks And Systems	25	25	1	0.9	0.282	0.171
ACM International Conference Proceeding Series	8	4	0.5	1.5	0.233	0.253
AIP Conference Proceedings	7	1	0.14	0.5	0.291	0.152
Studies In Systems Decision And Control	7	1	0.14	1.6	0.0	0.116
Communications In Computer And Information Science	6	8	1.33	1.1	0.246	0.203
Advances In Intelligent Systems And Computing	5	48	9.6	0.9	0.215	0.373
Lecture Notes In Electrical Engineering	5	1	0.20	0.7	0.145	0.147
E3s Web Of Conferences	4	1	0.25	0.9	0.4	0.182
IFIP Advances In Information And Communication Technology	4	0	0	1.6	0.346	0.242
Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	4	47	11.75	2.6	0.59	0.606

Source: Author's Elaboration

There are strong publishing outlets within the field. Ten journals have published more than one paper on this subject matter, which represents a strong amount of academic interest. The leading journal is "Lecture Notes in Networks and Systems," with 25 publications but with a low Cite Score of 0.9. "Advances in Intelligent Systems and Computing," publishing fewer papers (5), has the highest citation impact per paper (CPP 9.6), suggesting strong influence. Likewise, "Lecture Notes in Computer Science" has a high CPP (11.75) and leads in Cite Score (2.6) and SJR (0.606), making it the most influential journal among the top venues. The top-tier journals include "Studies in Systems Decision and Control" and "IFIP Advances in Information and Communication Technology," which have very few citations and low CPPs despite having published multiple articles. This disproportionate level of Cite Score, SNIP, and SJR among the same set of journals indicates the wide spread of diversity of impact that each might attract, reaching smaller and niche audiences. This kind of scattering of publication sites accounts for a high range of interest and impact, while some

journals shine through with their force of citations and academic reach.

3.6 Worldwide Publications

Eleven different countries have published documents concerning the topic. As indicated by the map and table provided, a high concentration in the published number can be seen in some countries, therefore indicating the regional strengths in this researched area. India leads the numbers with the highest at 150, a high repute demonstrated dominance and special interest in the topic. The Russian Federation comes next with 23 documents, which shows notable engagement from this region. Jordan, China, and the United Arab Emirates also frequently appear with 21, 19, and 18 documents, respectively, and thus represent active participation. Indonesia has 17 documents with a moderate level of academic production. Saudi Arabia and the United Kingdom, with 15 documents each, demonstrate that the entire world is interested in this work. Bahrain, Turkey, and the United States, with 12-14 documents each, complete the list with diversified geographical coverage. The distribution in this list clearly points out the global spread of research in this area and the disparity in academic contributions in each country. The number of publications from these countries highlights their importance in the development of discourse

and expanding knowledge on the subject. This is reflected in the high concentration in a few countries, emphasizing their role in the shaping and dissemination of insights in this research field.

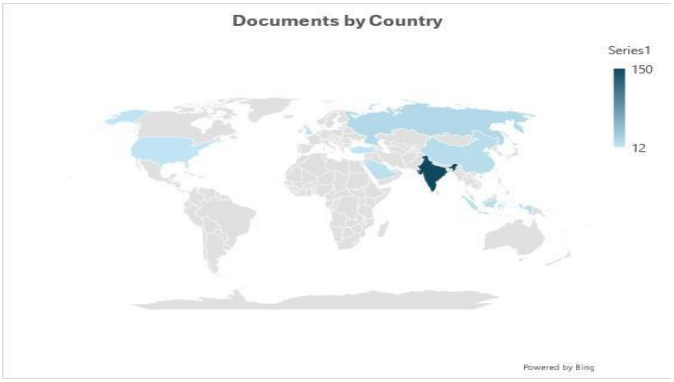

Figure 5: Worldwide Publication Source: Author's Elaboration

3.7 Document by Institution

Table 5: The top 10 institution Sources based on the number of publications

Organization	TP	TC
Ahlia University, Manama, Bahrain	5	24
Applied Science Research Center, Applied Science Private University, Amman, Jordan	3	17
Icfai Business School, The Icfai University, Dehradun, India	2	10
Quality And Operations Management, University Of Johannesburg, Johannesburg, South Africa	2	12
Universitas Indonesia, Jakarta, Indonesia	2	13
University School Of Business, Chandigarh University, Mohali, India	2	4
Uttaranchal Institute Of Management, Uttaranchal University, Dehradun, India	2	5

Uttaranchal University, Law College Dehradun, Dehradun, India	3	12
Uttaranchal University, Uit, Division Of Research & Innovation, Dehradun, India	2	7
Uttaranchal University, Uit, Division Of Research And Innovation, Dehradun, India	2	5

Source: Author's Elaboration

A high concentration of contributions spread over fewer institutions was shown in the artificial intelligence study on research productivity and impact within the bank sector. Ahlia University had the highest publication with 5 articles and a total citation TC count of 24. Similar results can be found at the Applied Science Research Center of Applied Science Private University in Jordan, which has a high impact factor with 3 publications and 17 citations. This may be reflective of effective output relative to its publication count. Indian institutions are also strong contributors, with Uttaranchal University repeated several times across the divisions. Collectively, Uttaranchal University has contributed a total of 7 publications, though citation counts vary, with Uttaranchal University Law College achieving the highest TC (12) among its divisions. This distribution shows that Uttaranchal University has been very active in the research of AI and banking, though it indicates some variability in the impact of individual publications. Universitas Indonesia and the University of Johannesburg have 2 publications with TCs of 13 and 12, respectively, and present a good academic presence and moderate citation

impact, hence an emerging but meaningful role in the discipline. The general theme of this data points out the global and inter-disciplinary nature of research on AI in banking with the bulk of the contribution from institutions based in the Middle East, South Asia, and Africa that have each made worthwhile contributions to the knowledge frontier.

3.8 Co-Occurrence of keywords

The co-occurrence network represents the distribution of research focus in the domain of AI in the banking industry. The goal of this analysis is to identify key and emerging areas within this research landscape by examining the clustering of keywords and their relationships. A total of 408 documents and 2029 unique keywords formed the basis of the network. This used minimum co-occurrence thresholding and ensured that the keyword appeared at least five times across documents to bring about statistically significant clusters. Among the set of keywords within the initial pool, 119 fit this criterion and were then grouped using a density-based clustering approach, which brought about six different clusters represented by differently colored circles in the network. Keywords like "artificial intelligence," "banking sectors," and even "banking" itself make up the nucleus of this network in the form of bigger circles. Such key terms are often considered the main foundation of literature; the scope of AI-application-focused research studies about the financial industry yet interlinks between central terms and highly connected concepts indicate that discussions on AI in banking are rather broad and interdisciplinary. For instance, cluster groups deal with issues of digital security and infrastructure, so they are clustered together under the umbrella of "cybersecurity", "data privacy", and "blockchain technology" (Cluster 1); on the other hand, one might argue that they fit into keywords that point towards customer-facing applications, thus having a two-pronged focus on security as well as customer satisfaction.

Each of the clusters in the visualization marks a theme of study all by itself in the greater context of AI and banking. Cluster 1 (Red): contains the terms "blockchain," "cloud computing," and "network security"; thus, it puts forth Digital Security and Infrastructure in Banking, wherein it strongly underscores the fact that digital frameworks need to be highly secure and reliable. Cluster 2 (Green) keywords include fraud detection, risk assessment, and the financial system, which suggest a significant focus on Risk and Fraud Management in Financial Systems. The other major clusters tell

different yet related research themes. For example, Cluster 3 (Blue) had

been based around keywords including customer churn prediction, data mining, and machine learning, thus focusing on Customer Analytics and Decision Support in Banking. This cluster seems to point to the immense interest displayed in using predictive analytics to enhance customers' engagement and ultimately optimize financial decision-making processes.

The terms used under Cluster 4 (Yellow) are "digital transformation," "robotic process automation," and "competitive advantage," which leads to AI-driven digital Transformation and Operational Efficiency in banking operations. This cluster reflects the adoption by the banking sector in the implementation of AI in process automation and competitive positioning. Cluster 5 (Purple) includes the terms "chatbots," "NLP," and "ethical technology," which use a theme related to Conversational AI and Ethical Considerations that have to do with the ethical implications of AI in customer interactions. Finally, Cluster 6 (Sky Blue) represents Service Quality and Innovation in Banking Services, with a focus on discussing "customer satisfaction," "service quality," and "innovation." Fewer nodes appear on the periphery, such as "public relations" and "personnel," pointing out niche directions in the area that may be further explored and contributed to through scholars' work. The connections and patterns seen in the network reflect the existing areas of research while at the same time indicating emerging topics that can be avenues for future investigation within AI applications within the banking industry.

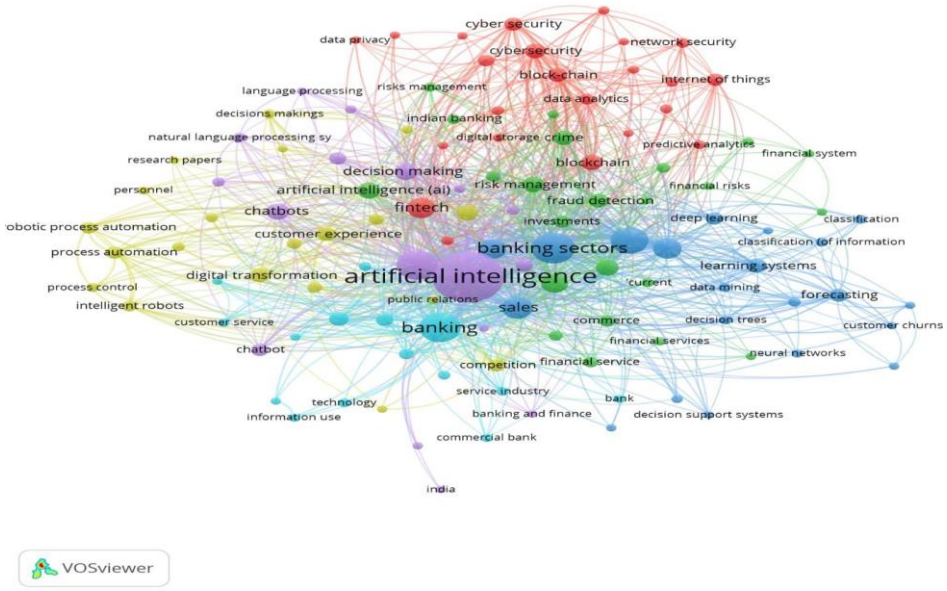

Figure 6: Bibliometric network of the keyword Co-Occurrence Source: Author's Elaboration

Table 6: Top Clustering in Sustainable Leadership

Cluster	Keywords	Derived Theme
Cluster 1 (red)	authentication, block-chain, blockchain, blockchain technology, cloud computing, customers' satisfaction, cyber security, cybersecurity, data analytics, data privacy, digital banking, digital storage, digital technologies, engineering education, financial	Digital Security and Infrastructure in Banking
	technology, fintech, internet of things, mobile banking, mobile bankings, network security, on-line banking, predictive analytics, systematic literature review.	

Cluster 2 (green)	'current, anomaly detection, artificial intelligence (ai), banking systems, behavioral research, commerce, crime, electronic commerce, finance, financial industry, financial institution, financial markets, financial risks, financial service, financial services, financial system, fraud detection, Indian banking, investments, long short-term memory, risk assessment, risk management, risks management.	Risk and Fraud Management in Financial Systems
Cluster 3 (blue)	The banking sector, banking sectors, classification, classification (of information), credit risk, customer churn prediction, customer churns, data mining, decision support system, decision trees, deep learning, forecasting, learning systems, logistic regression, machine learning, machine learning mode, machine learning, neural networks, prediction, sales, support vector machine.	Customer Analytics and Decision Support in Banking
Cluster 4 (yellow)	artificial intelligence technologies, banking institutions, banks, big data, case studies, competition, competitive advantage, customer experience, decision-making, digital transformation, efficiency, industrial revolutions, intelligent robots, personnel, process automation, process control, public relations, research papers, robotic process automation, robotics.	AI-Driven Digital Transformation and Operational Efficiency
Cluster 5 (Purple)	ai, artificial intelligence, banking and finance, banking industry, chatbot, chatbots, ChatGPT, decision making, ethical technology, India, information management, language processing, learning algorithms, natural language processing, natural language processing system, security, technological advancement.	Conversational AI and Ethical Considerations
Cluster 6 (sky	Bank, banking, banking services, commercial bank, customer satisfaction, customer service, financial sectors, information systems,	Service Quality and Innovation in Banking
blue)	information use, innovation, quality of service, service industry, service quality, technology.	Services

The theme of Digital Security and Infrastructure in Banking captures the essence in which the banking industry is investing in developing high-security digital architecture, secure hosting and safeguarding customer data, and allowing for smooth data-driven services through greater support. Cybersecurity, customer satisfaction, and enhancement of data privacy by means of predictive analytics to manage the digital banking experience seem to be dominant. The theme, Risk and Fraud Management in Financial Systems, uses technology like AI linked to anomaly detection and long short-term memory networks in discovering risks and frauds. The cluster focuses on assessing financial risk in the banking system operated through AI for maintaining financial stability in a high-pressure environment. The cluster focus would obviously remain on understanding customer behavior through the implementation of machine learning techniques, such as deep learning, to mine the data for predicting churn, managing credit risk, and supporting strategic decisions. This set of analytical tools ultimately improves banks' abilities to predict their customers' needs and implement optimum credit management activities.

The theme of AI-driven digital transformation and operational efficiency signifies the incorporation

of AI, robotics, and big data analytics into transforming the operational functions of banking operations. The employment of tools like RPA and process control would thus create an age of efficiency in banks by creating competitive advantages, fostering customer satisfaction through automating processes and enhancing decision-making functions. Conversational AI and ethical considerations encourage building rapport actively, which bulls forth due to the increasing application of natural language processing (NLP) and chatbots, as the theme lines up how banks upgrade customer interactions via conversational AI, with the ethical ramifications and security issues associated with using AI in customer-facing roles. Service Quality and Innovation in Banking Services focus on customer satisfaction, the quality of the service offered, and technological innovation of the services offered, reflecting a customer-centered approach. The banks have transmitted service quality through technological improvements as responses to changing consumer expectations in the banking sector. The themes feature experiences of where AI is transforming banking, therefore pointing to trends and priorities such as the enhancement

of security, personalization in the customer experience, and ethically implementing AI in the delivery of services.

3.9 Co-Authorship of Authors

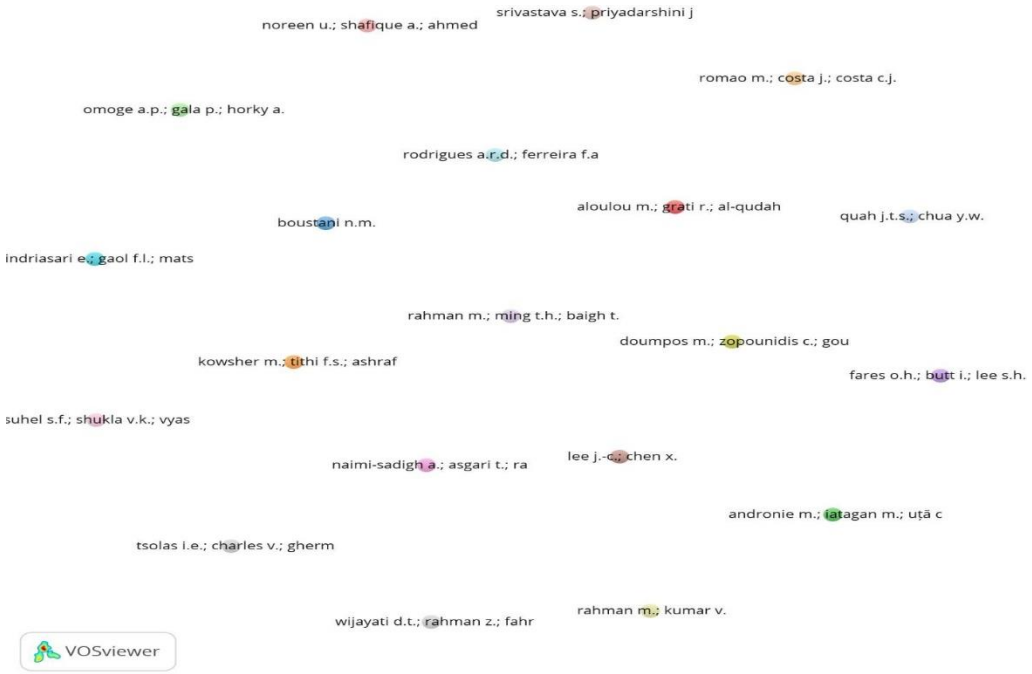

Figure 7: Bibliographic Network of the Co-authorship of Authors Source: Author's Elaboration

However, the analysis suffers from some limitations. Data inconsistency-the differences

in the author's name formats (using initials and using full names)-may artificially separate connected individuals, which can break up the network. A higher threshold in the co-authorship visualization might have excluded the one or two papers in which some authors may only participate, so the network looks less connected than it would be at a lower threshold. Another limitation of the dataset is that it might not cover all relevant literature because of its restricted

sources, and especially non-indexed sources may be underrepresented, which diminishes the co-authorship representation. An expanded dataset and standardization of names may provide a more realistic image of the patterns of collaboration in this particular research domain.

The network of co-authorship of those authors participating in the field of AI research in banking is

overall very fragmented, where most of the authors are considerably working alone in isolated groups or with no substantial collaboration links. This creates a situation that may indicate researchers in this field tend to confine their work within particular institutional boundaries or some specific geographical locations, where wider sharing of ideas toward broader collaboration is limited. The sparse connections, although forming some interesting clusters, point to a need for more inter-institutional as well as international research efforts. This gap in connectivity may also hinder the emergence of a coherent knowledge base because collaboration networks are a source of pooled expertise, resources, and diversity of ideas.

4. Discussion

A Bibliometric Analysis of Artificial Intelligence in the Banking Sector: Trends and Future Directions" tests the intellectual landscape and growth of AI research in the banking realm using a comprehensive bibliometric analysis. Over the past five years, AI applications in banking have increased, indicating a wider recognition of the potential of AI in aspects related to risk management, customer service, and also operational efficiency, among others. This focus is seen in multiple themes-from fraud detection upgrades using machine learning models to the optimization of customer engagement with natural language processing and integration of chatbots. Preliminary research was primarily on the theory, like how AI can potentially change the game in banking, mainly through increased security and productivity (Königstorfer et al., 2020). The past few years of empirical research, though, resonate with the mainstreaming of practical directions because more banks rely on AI and solutions that operate at the platform level to realize benefits in real-time fraud detection, routinization of routine activities, and improvements in credit risk assessment through predictive analytics (Jyothi et al., 2024; Fundira et al., 2024). The applications further emphasize the shift from theoretical discourses toward practical work on how to address specific operational challenges in banking.

The COVID-19 pandemic made AI technologies speedier and more interesting for banks to innovate and enhance their agility in operation under the new constraints. This period also

brought forward the need for digital resilience and responsiveness in which AI would play a central role in maintaining the services running in banks. Studies on AI-based customer service tools, such as chatbots, which enabled client interactions without disruption during lockdowns, further focused on the growing importance of digital transformation for banking operations (Thamrin et al., 2024). In addition, the pandemic raises ethical issues about data protection and security because banks are increasingly relying on customer data for customized services. AI research in the banking sector has gained tremendous global momentum; to date, significant contributions have been made from regions like South Asia, Europe, and North America. Therefore, the widespread geographic reach of AI research is a reflection of global acceptance of what this technology brings. However, still, there are still strong regional-specific challenges and gaps in AI-related research, as reflected in the example below. The development of leading innovations in applications is found in countries with advanced digital infrastructure, such as the United States and Europe. On the other hand, foundational research and infrastructure development to support AI adoption seems to be at the forefront of countries in South Asia.

This bibliometric analysis yields results indicating AI as a transformative entity for banking in terms of better decision-making processes, higher customer experience standards, and risk minimization opportunities on the operational front. Further research could address some of the gaps that exist today, like the ethical implications associated with the use of AI and integrations posed by older systems. The results reflect emerging trends in applications of AI- explainable AI and quantum computing are likely to revolutionize banking further. This bibliometric study is also a road map for

future exploration, pointing out the need for sustainable, inclusive, and ethical AI solutions in banking.

5. Conclusion

The study presents a bibliometric analysis of the research on artificial intelligence within the banking sector, outlining dynamic advancement and trends over the last five years. Findings further point to an AI revolution transforming the modality of operations in the banking sector through enhanced efficiency, customer experience, and reduced risks. In the beginning, most of the attention was mainly on basic, theoretical research in the area, including effects like increased productivity as well as effects on customer service. Over time, however, empirical applications have developed into an increasingly valuable area of study, focused on real-time

fraud detection, predictive analytics for credit risk, and automation of operations. This trend also heralds greater acceptance of AI as not just a novel concept but an operationally critical component for banks. The study draws attention to the role that geographic considerations play in the contributions of research; major work comes from South Asia, Europe, and North America. The study reflected the universal interest in AI in banking and region-specific challenges and gaps. So, with the evolution of the banking sector, the study has preserved that AI-driven solutions are ever more important to get a creative and safe as well as ethical balance.

Recommendations

Accordingly, the outcome of the research would depict a future direction toward solving issues like data privacy issues related to AI usage in banking and the issue of algorithmic bias and transparency in AI outputs. Integration with legacy banking systems forms yet another significant issue; thereby, research on developing compatible AI solutions or upgrading the necessary infrastructure would benefit particularly. More interdisciplinary research in this field would really be great. Researchers should engage in research across more institutions and seek partners in all places. This could help have a more integrated research community that would share more and maybe come up with great findings. Funding bodies and academic institutions could encourage co-authorship, especially when resources and platforms would support collaboration between different regions.

Limitations

The study was limited to publications coming from the Scopus database, which might exclude some research outside of other sources, such as those from Web of Science or Google Scholar. Diversification of the coverage of the databases may allow for a broader perspective of the research landscape. The major limits of this co-authorship analysis are basically in the data sources used. This visualization would only be based on a smaller sample size and just be using data from particular databases; hence it would possibly not include all the relevant authors or collaborations. Extending the analysis to more than just extra databases and language-specific research may give a more comprehensive view of the worldwide collaboration in this type of research.

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